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(71) LIZOTTE CONSULTANTS LTEE,
4, rue Montreuil, RIVIERE-VERTE, N3 (CA).

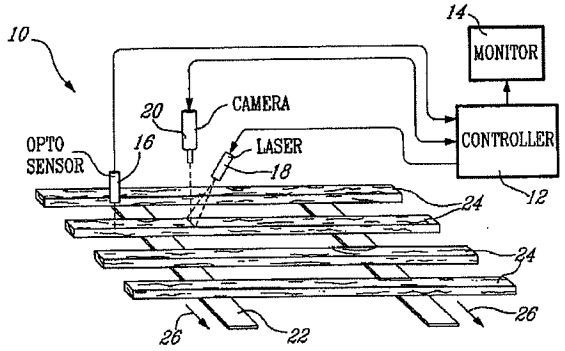
(72) VARGHESE, ZUBIN (CA).
STEVENS, ROBERT W. C. (CA).
GAGNON, PHILIPPE (CA).
LIZOTTE, MARCEL (CA).

(74) GOUDREAU GAGE DUBUC

(54) SYSTEME DE DIFFERENCIATION DES ESPECES DE BOIS
(54) WOOD DIFFERENTIATING SYSTEM

(57)

A wood differentiating system comprising a line-forming laser, a camera and a controller is described herein. The line-forming laser projects a line of laser light onto a wood lumber and the camera takes a picture of the illuminated area of the wood lumber. By evaluating how the fibers of the wood scatter light, the controller is capable of differentiating between lumber made of fir and lumber made of spruce, for example.



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(71) Demandeur/Applicant:
LIZOTTE CONSULTANTS LTEE, CA

(72) Inventeurs/Inventors:
LIZOTTE, MARCEL, CA;
VARGHESE, ZUBIN, CA;
STEVENS, ROBERT W. C., CA;
GAGNON, PHILIPPE, CA

(74) Agent: GOUDREAU GAGE DUBUC

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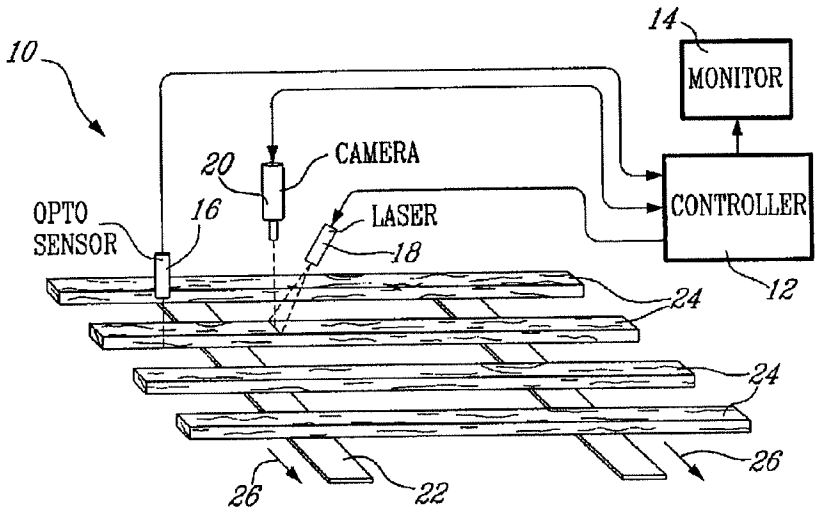


(57) Abrégé/Abstract:
A wood differentiating system comprising a line-forming laser, a camera and a controller is described herein. The line-forming laser projects a line of laser light onto a wood lumber and the camera takes a picture of the illuminated area of the wood lumber. By evaluating how the fibers of the wood scatter light, the controller is capable of differentiating between lumber made of fir and lumber made of spruce, for example.

ABSTRACT OF THE DISCLOSURE

A wood differentiating system comprising a line-forming laser, a camera and a controller is described herein. The line-forming laser projects a line of laser light onto a wood lumber and the camera takes a picture of the illuminated area of the wood lumber. By evaluating how the fibers of the wood scatter light, the controller is capable of differentiating between lumber made of fir and lumber made of spruce, for example.

TITLE OF THE INVENTION

WOOD DIFFERENTIATING SYSTEM

FIELD OF THE INVENTION

The present invention relates to wood differentiating systems. More specifically, the present invention is concerned with a system designed to differentiate between different wood species.

BACKGROUND OF THE INVENTION

The similar geographic range and common occurrence of mixed strands of spruce and fir, for example in Eastern Canada and Northeast United States, has led to the practice of harvesting these two species without separation.

Since spruce and fir demonstrate different drying time and shrinkage potential, kiln drying schedules must be based on the longest drying time, i.e. the drying time of fir, to ensure complete drying of the mixed load. Of course, this often results in over-drying of the spruce lumber whose tendency towards twisting is thereby increased, leading to the downgrading of the spruce lumber.

There is therefore a need for a wood differentiating system designed to efficiently and cost effectively differentiate between different types of

wood, such as, for example, wood worthy of being dried and wood not worthy of being dried, before they are further processed. Furthermore, there is a need for a wood differentiating system that may further differentiate between lumber that is worthy of being dried, such as, for example, spruce and fir.

OBJECTS OF THE INVENTION

An object of the present invention is therefore to provide a wood differentiating system.

Other objects, advantages and features of the present invention will become more apparent upon reading of the following non restrictive description of preferred embodiments thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the appended drawings:

Figure 1, is a schematic view of a wood differentiating system according to an embodiment of the present invention;

Figure 2, is a schematic view of a fir lumber as seen from the camera of the system of Figure 1;

Figure 3, is a schematic view of spruce lumber as seen from the camera of the system of Figure 1;

Figure 4, is a schematic flow chart of the operation of the wood differentiating system.

Figure 5, is a schematic view of a wood differentiating system according to a second embodiment of the present invention;

Figure 6, is a side elevational view of the line-forming laser and of the camera of the system of Figure 5; and

Figure 7, is a schematic view of a wood differentiating system according to a third embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Generally stated, the present invention described hereinbelow has been developed to differentiate between spruce and fir using the principle of light scattering in the wood. The wood lumber is illuminated by a line-forming laser and at least one image is captured by a camera. The width of the light scattered along the fibers of the wood is measured and averaged to differentiate between spruce and fir. This information is then used to mechanically separate the different types of wood, such as, for example, wood worthy of being dried and wood not worthy of being dried, before they are further processed. Furthermore, this information is used to separate lumber worthy of being dried on a schedule optimized for the species of concern, for example, spruce and fir.

Turning now to Figure 1 of the appended drawings, a wood differentiating system 10 according to an embodiment of the present invention will be described.

The wood differentiating system 10 includes a controller 12 provided with a monitor 14, a sensor 16, a line-forming laser 18 and a camera 20. The sensor 16, laser 18 and camera 20 are connected to the controller 12.

As can be seen from this figure, the sensor 16, laser 18 and camera 20 are mounted above a conveyor assembly 22 that transversally moves lumber 24 (see arrows 26).

The sensor 16 is so mounted that it detects a leading edge of a lumber 24 and transfers this data to the controller 12. The laser 18, is so positioned that the transversal line of laser light it projects is upon a lumber when the leading edge of the lumber is detected by the sensor 16. The camera 20, is so positioned as to have it's field of view axis perpendicular to the top surface 25 of the wood lumber 24. Furthermore, the camera 20 is so positioned that it may capture, from an angle, images of the projected line on the lumber 24 when the lumber 24 is detected by the sensor 16. The angle between the projection axis of the laser and the field of view axis of the camera 20 are comprised in a plane comprising the projected laser line.

The bi-directional link between the camera 20 and the controller 12 is such that the controller may trigger the camera 20 and receive images therefrom for further processing. Similarly, the link between the laser 18 and the controller 12 allows the controller to control

the state of the laser. It is to be noted that the link between the laser 18 and the controller 12 is optional. Indeed, the laser 18 could be powered on when the system 10 is energized and powered on a continuous basis without being controlled by the controller.

Turning now to Figure 4 of the appended drawings, illustrating a schematic flow chart of the operation running in the controller 12, and to Figures 2-3 illustrating images taken by the camera 20, the operation of the wood differentiating system 10 will be described.

The first step is the start of the wood differentiating system 10 (step 100). The system is then initialized in step 102. In step 104, the system waits for the sensor 16 to detect the front edge of a lumber 24.

When a lumber 24 is detected, the system 10 is ready to take a predetermined number N of pictures of the scattered light from the line producing laser 18. In step 106, a counter ("number of pictures") is set to zero (0) before a first image is taken (step 108). The "number of pictures" counter is then incremented in step 110.

The picture is then processed to remove the portion of the image that is directly illuminated by the laser 18 (step 112). This directly illuminated portion is identified by numeral 30 in Figures 2 and 3. The remaining of the illuminated portion (see numerals 32 and 34 in Figures 2 and 3, respectively) of the lumber is therefore illuminated due to the scattered light along the fibers of the wood.

In step 114, the width of the scattered light on both sides of the projected laser line is averaged. This width is represented by arrows 36 and 38 in Figures 2 and 3, respectively.

The system then verifies if the "number of pictures" counter is equal to the predetermined number N of pictures to be taken (step 116). If this is not the case, steps 108-116 are repeated until N pictures have been taken.

When the predetermined number N of pictures has been taken, the system exits the loop and the system then calculates the average of the average width of the N pictures (step 118).

To illustrate the difference between the average width of a scattered light of a fir lumber and a spruce lumber, we will now briefly turn to Figures 2 and 3. It is to be noted that Figure 2 schematically illustrates a typical image captured by the camera 20 when the lumber 24 is made of fir while Figure 3 schematically illustrates a typical image captured by the camera 20 when the lumber 24 is made of spruce. As will be understood by one skilled in the art, the average width of the scattered light in the fir lumber is thinner than the average width of the scattered light in the spruce lumber. It is therefore possible to differentiate the species of wood by detecting and calculating the average width of the scattered light.

Referring back to Figure 4 of the appended drawings, in step 120, the system determines if the average width is less than a first threshold. If so, the lumber should be sold as wood chips (step 122) and this information is supplied to the conveyor system for further action.

Indeed it has been found that if the width of the scattered light is very small, the quality of the wood is not sufficient to produce quality dried wood.

On the other hand, if the average width is more than the first threshold, then it will be submit to a second differentiation process. Indeed, in step 124, the system determines if the average width is less than a second threshold. If so, the lumber should be sold as green wood (step 126). It has been found that if the scattered light is between the first and second thresholds, the wood is not suitable for drying purpose and should be sold as green lumber.

If it's not the case, i.e. if the average width is not less than the second threshold, then the lumber undergoes a third and final differentiation process in step 128. In this step, the system determines if the average width is less than a third threshold. If so, the lumber is determined to be fir (step 130) and dried accordingly, if not, the lumber is determined to be spruce (step 132), and dried accordingly. Again, all the information coming from these differentiation and comparative procedures, are supplied to the conveyor system for further action.

It is to be noted that to attain a complete and functional wood differentiating system according to this embodiment of the present invention, additional algorithms could be required. Indeed, the positioning angle of the laser and the possible variation of the wood thickness cause the relative position of the projected laser line in the image to vary. Accordingly, additional steps would be required to find the light projected on the wood.

Example:

As a non limitative example, a wood differentiating system having the following features has been found appropriate.

Sensor 16: model 42SRP-6002 made by Allen-Bradley

Laser 18: model 670-30-20-30 made by Lasiris
Wavelength: 670 nm;
optical power: 30 mW;
fan angle: 20°;
working distance: 30 cm

Camera 20: model M2SC/HSS1 made by IVP Integrated Vision Products AB; the distance from the camera and the lumber is on the order of 8 inches.

The controller 12 is provided with a data acquisition card made by IVP under model SC adapter board #10 (7.51 PLD). This card is advantageously able to quickly acquire image data at about 330 Mbits per second. The predetermined number N of pictures to be taken of each lumber has been set to 25. This relatively large number of pictures to be taken of each lumber is advantageous since it significantly decreases the importance of the average width of the scattered light of each picture in the final average of the width for the entire array of pictures, thereby increasing the reliability of the system.

With this setup, it has been found that the cut-off number of pixels (first threshold) to determine if the wood is worthy of being dried or not is 70, i.e., if the final average width is smaller than 70

pixels the lumber should be sold as chips. If not, the lumber undergoes a second comparison which involves a second threshold of 100 pixels. Hence, if the average width is smaller than 100 pixels, the lumber should be sold as green lumber. Finally, the third threshold that determines if the lumber is made of fir or spruce (or should be dried as fir or spruce) is 140, i.e., if the final average width is greater than 140 pixels, the lumber is dried as spruce, if not, it is dried as fir.

A second embodiment of the present invention will now be described with reference to Figures 5 and 6 of the appended drawings.

The foregoing consists of a wood differentiating system 200 similar to the system of Figure 1 except for the positioning of the camera and of the laser.

Figure 5 illustrates a wood differentiating system 200 according to the second embodiment, where, in contrast to the system 10, the laser 18 is so positioned that the laser projection axis is perpendicular to the top surface 25 of the lumber 24. As for the camera 20, it is so positioned that its field of view axis and the projection axis of the laser define an angle, itself defining a plane including the line formed by the laser. This arrangement between the laser 18 and the camera 20, allows the camera 20 to always capture the line projected by the laser 18 as a straight line at the same location in the image.

As it can be seen from Figure 6, which is a side elevational view of both laser 18 and the camera 20. From a longitudinal perspective view of the lumber 24, it can be seen that the projection axis of the laser 18 and the field of view axis of the camera 20 are in the same

plane that includes the projected laser line.

As it will easily be understood by one skilled in the art, since the projected line from the laser 18 and the field of view axis of camera 20 are in the same plane, variation of the thickness of the lumber 24 will not cause a movement of the laser line in the image.

Turning now to Figure 7 of the appended drawings, a wood differentiating system 300 according to a third embodiment of the present invention will be described.

It is to be noted that a first detecting system comprising a laser/camera combination 18, 20 is identical to the combination of Figure 5, and therefore, will not be described in further details hereinbelow, for concision purposes.

From Figure 7, it can be seen that a second detecting system comprising a light/camera combination has been added to the wood differentiation system described in systems 10 and 200. A minor drawback encountered in systems 10 and 200, is that the laser system performs poorly in some instances. Indeed, when the lumber comes with surface anomalies such as non-evenness or roughness, it becomes more difficult for systems 10 and 200, to accurately differentiate between the various kinds of lumber thereon.

Nevertheless, the system 300 solves these minor drawbacks. From the system 300, a fluorescent toroidal-lamp 40 and a black and white (B & W) camera 42 are also provided to increase the accuracy of the differential action of the system.

It should be mentioned that the fluorescent toroidal-lamp is located above a plane of the face of lens of the (B &W) camera 42. Furthermore, the field of view axis of the (B&W) camera 42 and an axis of said fluorescent toroidal-lamp 40 that passes through a center of the toroidal lamp 40, are collinear.

As known in the art, the combination of a constant projected light as the fluorescent light 40 and the (B & W) camera 42, is used to grade the wood based on the overall gray level of the image.

As for the other elements and connections of the overall wood sorting system 300, they are all similar to the two previous embodiments. However, several aspects of the working operations differ and will be broadly described hereinbelow.

In operation, the steps involved are similar to the ones shown in Figure 4. However, in this third embodiment, these steps are applied twice (for the light 40/(B &W) camera 42 and the laser 18/camera 20 systems) and are combined and compared at the end to separate the fir lumber from the spruce lumber.

As in the system 10, it can be seen from Figure 7 that the bi-directional links between the cameras 42, 20 and the controller 12 and the link from the controller 12 and the laser-light 18, 40 generate a controlled differentiating technique to capture images of an area of the lumber 24. This is similar but more efficient than the two prior systems, since two differentiating techniques are used.

Once the leading edge of the lumber 24 is detected by the sensor 16, the camera 20 executes the same procedures as described

in systems 10 and 200. Simultaneously, the (B&W) camera 42, captures an image of an area of the wood and excludes the extremely light and extremely dark areas from further evaluation, but evaluates the remaining area on an overall gray level thereon. The resulted data from the added light/camera system is then compared to a threshold. As previously mentioned, the same is done with the resulted data of the first laser/camera system. This primal differential procedure of spruce / fir is followed by a logic combination. This final differentiation implies that if either of both systems display "fir", then the combinational logic display "fir". Whenever the two systems display different results, the final logic display will be "fir". It is only when both system display "spruce" that the combinational logic also display "spruce".

However, there is an alternate differential technique for the two-cameras system which involves having the two data resulted therefrom to be mathematically combined and the result thereof be compared to a single threshold. The mathematical combination may be done by simple addition, or one of the results is multiplied by a factor and added to the other. Furthermore, it can involve a result being raised to a power or simply having the two results multiplied together.

It is to be understood that the resulted data from the two-cameras system, as well as in the previous system 10 and 200, are in the form of digital data and therefore may go through digitized treatments known in data processing practice. Therefore, the various camera-based modules involve in the present invention, can communicate

a numeric signal (known as pseudo-analogue signal) to a master algorithm, and the foregoing will generate the final output of the system.

It should also be noted that means for displaying the results are done according to the previous descriptions of the determination of the average width of scattered light and the evaluation of the overall gray level of the captured images.

Hence, the combined results from the two mentioned laser-light/camera systems allow to increase the accuracy of separating the fir from the spruce.

It will be apparent to one skilled in the art that other alternatives are applicable to the present invention. The sensor, for example, may also be triggered by the tailing edge of the wood lumber before the camera captures an image of a portion thereon.

Moreover, it is possible to position the laser described in the second embodiment (Figure 5), at one end of the wood lumber instead of the position shown in Figure 5 to consequently avoid some problems caused by the angle of the growth rings of the wood which are immediate to the area of testing.

It will also be understood by one skilled in the art that the step involving the removal of the portion of the image that is directly illuminated by the laser 18 and measuring the average width of the scattered light on both sides of the projected laser line, as seen on Figure 2 and 3; can be replaced by measuring and averaging the intensity of light of a lighted band projected by the laser. This band of light is located at a predetermined distance from the centered portion directly illuminated by

the laser. Furthermore, the intensity of light at the center of the portion directly illuminated by the laser may also be measured, and the ratio of the level thereof and the level of light at a certain distance therefrom would be used for subsequent calculations. It is to be noted that, according this alternatives, the thresholds will therefore be values of arbitrary unit of intensity instead of pixels as described hereinabove.

Although the present invention has been described hereinabove by way of preferred embodiments thereof, it can be modified, without departing from the spirit and nature of the subject invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A wood differentiating system for differentiating between wood lumber of different species comprising:

a controller;

a line-forming laser configured and positioned to selectively project a laser line onto a wood lumber; and

a camera connected to said controller; said camera having a field of view and being configured and positioned to have said projected laser line into said field of view and to capture an image of a portion of the wood lumber including said projected laser line;

wherein said controller is so configured as to analyze said captured image supplied by said camera to determine the width of scattered light on the wood lumber to differentiate between wood species.

2. A wood differentiating system as recited in claim 1, wherein the wood lumber is longitudinal, and wherein said projected laser line is transversally projected onto a top surface of the longitudinal wood lumber.

3. A wood differentiating system as recited in claim 1, wherein said camera is so positioned as to have it's field of view axis perpendicular to a top surface of the wood lumber.

4. A wood differentiating system as recited in claim 1, wherein a projection axis of said line-forming laser and a field of view axis of said camera form an angle, and wherein a plane comprising said angle

includes said projected laser line.

5. A wood differentiating system as recited in claim 1, wherein the wood lumber is conveyed by means of a conveyor, and wherein said system further comprises a sensor used to detect a leading edge of the wood lumber and to transfer the data to said controller to enable the camera to capture an image of a portion of the wood lumber including the projected laser line.

6. A wood differentiating system as recited in claim 5, wherein said line-forming laser is connected to said controller and is energized by said controller upon detection of the leading edge of the wood lumber by said sensor.

7. A wood differentiating system as recited in claim 1, wherein said line-forming laser is energized on a continuous basis.

8. A wood differentiating system as recited in claim 1, wherein said controller is so configured as to remove, from the captured image, a portion of the wood lumber directly illuminated by said projected laser line.

9. A wood differentiating system for differentiating between wood lumber of different species comprising:

a controller;

a first detecting system consisting of:

a line-forming laser; configured and positioned to selectively project a laser line onto a wood lumber;

a first camera connected to said controller; said first camera having a field of view and being so configured and positioned to have said projected laser line into said field of view and to capture an image of a portion of the wood lumber including said projected laser line;

a second detecting system consisting of:

a fluorescent lamp, said fluorescent lamp being configured and positioned to project fluorescent light onto a portion of the wood lumber;

a second camera connected to said controller; said second camera having a field of view and being so configured and positioned to have said fluorescent light into said field of view and to capture a black and white image of a portion of the wood lumber including said projected fluorescent light;

wherein said controller is so configured as to analyze said captured image supplied by said first camera to determine the width of scattered light on the wood lumber; said controller is also configured as to evaluate the overall gray level from said captured image supplied by said second camera; and wherein the combined result from said first and second detecting systems are used to differentiate between wood species.

10. A wood differentiating system as recited in claim 9, wherein said fluorescent lamp is toroidal-shaped.

11. A wood differentiating system as recited in claim 10, wherein said fluorescent lamp is located above a plane of a face of lens of said second camera.

12. A wood differentiating system as recited in claim 10,

wherein said field of view axis of said second camera and an axis of said fluorescent lamp passing through a center of the toroidal lamp are collinear.

13. A wood differentiating system as recited in claim 9, wherein the wood lumber is longitudinal, and wherein said projected laser line is perpendicularly projected onto a top surface of the wood lumber.

14. A wood differentiating system as recited in claim 9, wherein a projection axis of said line-forming laser and a field of view axis of said first camera form an angle, and wherein a plane comprising said angle includes said projected laser line.

15. A wood differentiating system as recited in claim 9, wherein the wood lumber is conveyed by means of a conveyor, and wherein said system further comprises a sensor used to detect a leading edge of the wood lumber and to transfer the data to said controller to enable the first camera to capture an image of a portion of the wood lumber including the projected laser line and to also enable the second camera to capture a black and white image of a portion of the wood lumber including the projected fluorescent light.

16. A wood differentiating system as recited in claim 15, wherein said line-forming laser is connected to said controller and is energized by said controller upon detection of the leading edge of the wood lumber by said sensor.

17. A wood differentiating system as recited in claim 9,

wherein said line-forming laser and fluorescent light are energized on a continuous basis.

18. A wood differentiating system as recited in claim 9, wherein said controller is so configured as to remove, from the captured image from first camera, a portion of the wood lumber directly illuminated by said projected laser line.

19. A wood differentiating system as recited in claim 9, wherein said controller is so configured as to evaluate, from the captured image from the second camera, the overall gray level of a portion of the wood lumber directly illuminated by said fluorescent projected light.

20. A wood differentiating system as recited in claim 9, wherein said controller is further configured to remove, from the captured image from the second camera, extremely light and extremely dark areas from further evaluation and evaluates the remaining area on an overall gray level of the wood lumber directly illuminated by said fluorescent projected light.

21. A wood differentiating system as recited in claim 9, wherein said results from said first and second detecting systems, are in the form of digital data.

22. A wood differentiating system as recited in claim 9, wherein said first and second detecting systems can communicate a numeric signal to a master algorithm for further processing.

23. A wood differentiating system as recited in claim 14, wherein said first camera is so positioned to have said field of view axis perpendicular to the top surface of the wood lumber.

24. A wood differentiating system as recited in claim 12, wherein said second camera is so positioned as to have said field of view axis perpendicular to the top surface of the wood lumber.

25. A wood differentiating method for differentiating between wood lumber of different species comprising the steps of:

projecting a line of laser light onto the wood lumber;

capturing an image of a portion of the wood lumber comprising the projected line of laser light;

processing the image to remove a portion directly illuminated by projected laser line of laser light;

determining the width of scattered light in the wood lumber; and

determining the species of wood lumber by comparing the width of scattered light with at least one threshold.

26. A wood differentiating method as recited in claim 25, wherein said capturing and processing steps are repeated until a predetermined number of pictures have been captured and processed.

27. A wood differentiating method as recited in claim 26, wherein said width determining step comprises calculating an average width of the measured width of the scattered light along the fibers of the wood.

28. A wood differentiating method as recited in claim 25, further comprising the steps of:

projecting a fluorescent light onto the wood lumber;

capturing an image of an area of the wood lumber comprising the projected fluorescent light;

processing said image to remove extremely light and extremely dark areas from the area of the wood lumber directly illuminated by said fluorescent projected light;

evaluating the remaining area on the overall gray level of said processed image; and

determining the species of wood lumber by comparing the overall gray level with a threshold.

29. A wood differentiating method as recited in claim 28, wherein the results of the thresholds comparisons are compared to differentiate between wood species.

30. A wood differentiating method as recited in claim 25, wherein said species determining step includes the sub-steps of:

comparing the width of the scattered light with a first threshold to determine if the lumber should be sold as chips;

comparing the width of the scattered light with a second threshold to determine if the lumber should be sold as green lumber;

comparing the width of the scattered light with a third threshold to determine if the lumber should be dried as "fir" or should be dried as "spruce".

31. A wood differentiating method as recited in claim 28, wherein comparison from said two methods are mathematically combined and the result thereof is compared to a single threshold.

32. A wood differentiating method as recited in claim 25, wherein said comparisons of said compared thresholds results display "fir", should said width of scattered light determining and said overall gray level determining steps display different results.

33. A wood differentiating system for differentiating between wood lumber of different species comprising:

a controller;

a line-forming laser configured and positioned to selectively project a laser line onto a wood lumber; and

a camera connected to said controller; said camera having a field of view and being configured and positioned to have said projected laser line into said field of view and to capture an image of a portion of the wood lumber including said projected laser line;

wherein said controller is so configured as to analyze said captured image supplied by said camera to measure and average the intensity of a lighted band projected by said line-forming laser on the wood lumber to differentiate between wood species.

34. A wood differentiating method for differentiating between wood lumber of different species comprising the steps of:

projecting a line of laser light onto the wood lumber;

capturing an image of a portion of the wood lumber comprising the projected line of laser light;

determining a distance of a lighted band from a centered portion directly illuminated by the laser;

measuring and averaging the intensity of the lighted band from the projected line of laser light; and

determining the species of wood lumber by comparing the values of intensity with at least one threshold.

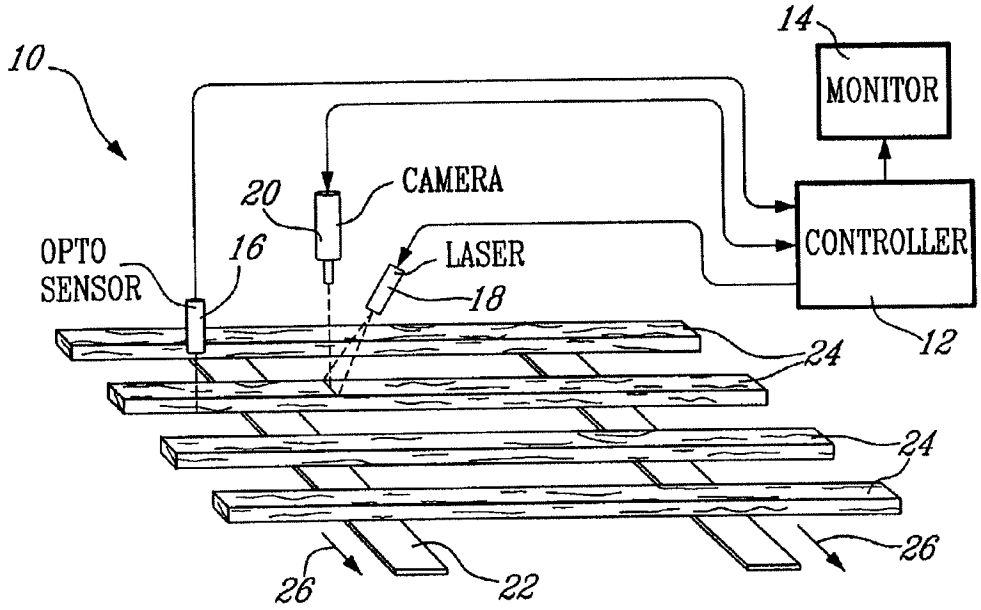


Fig. 1

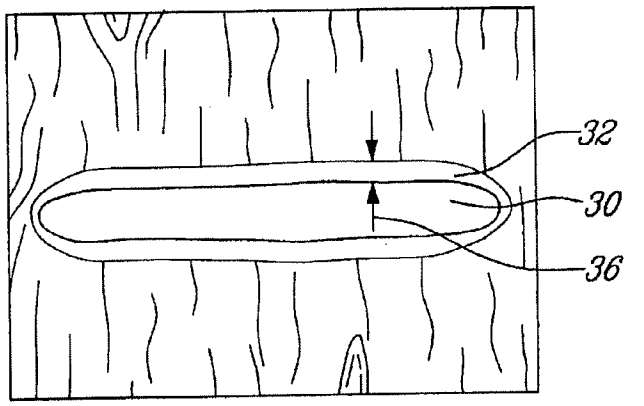


Fig. 2

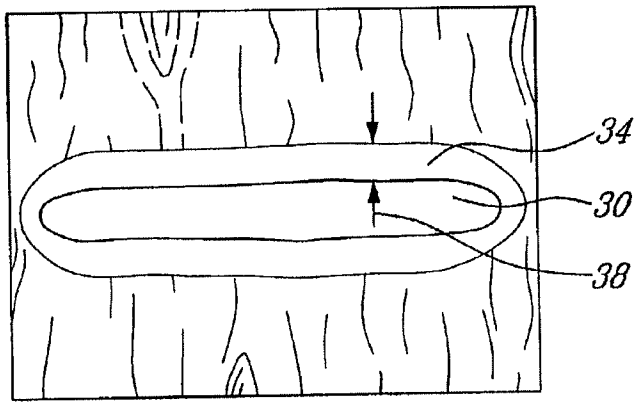
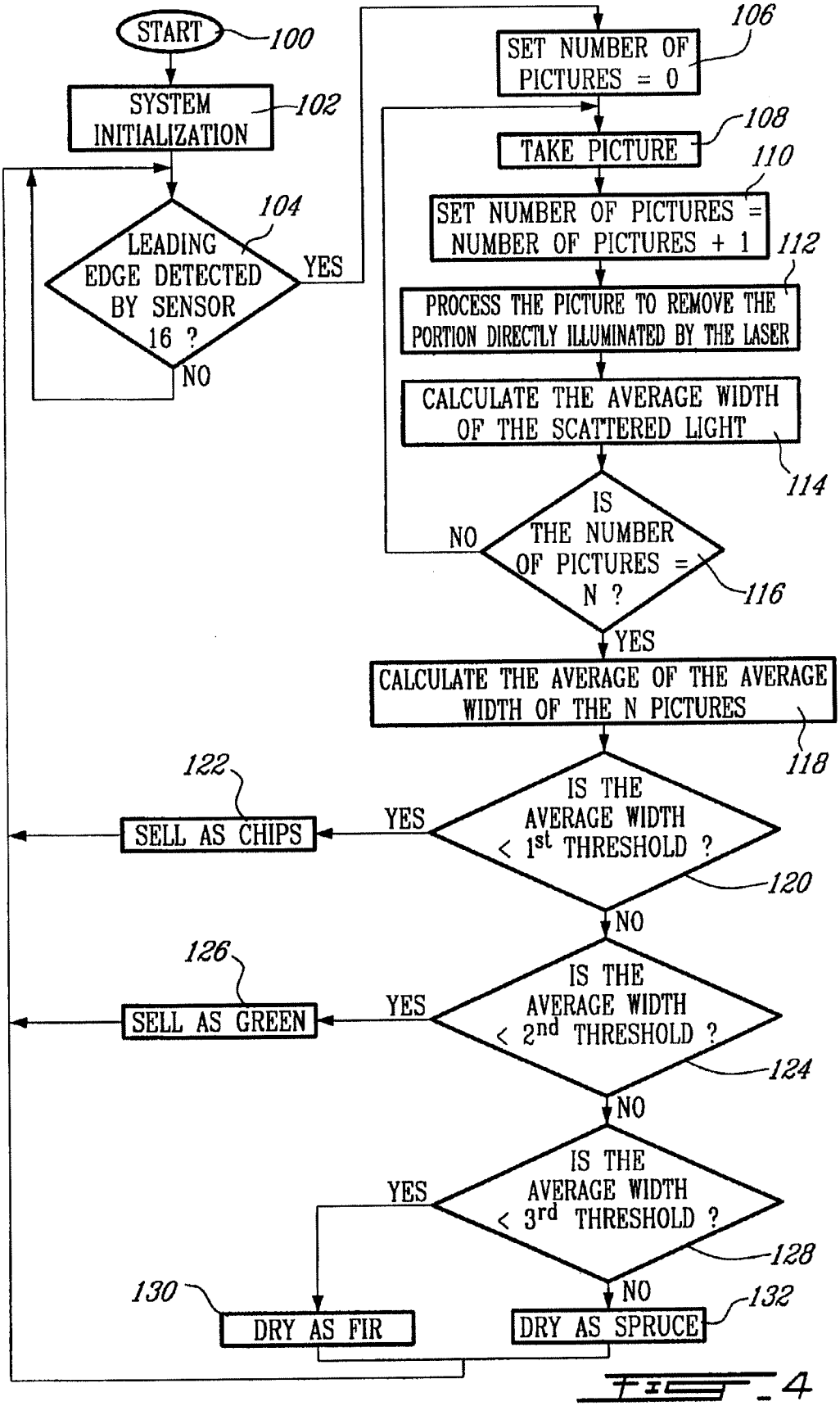


Fig. 3


START
100
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102
LEADING EDGE DETECTED BY SENSOR 16 ?
104
YES
NO
SET NUMBER OF PICTURES = 0
106
TAKE PICTURE
108
SET NUMBER OF PICTURES = NUMBER OF PICTURES + 1
110
PROCESS THE PICTURE TO REMOVE THE PORTION DIRECTLY ILLUMINATED BY THE LASER
112
CALCULATE THE AVERAGE WIDTH OF THE SCATTERED LIGHT
114
IS THE NUMBER OF PICTURES = N ?
116
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YES
CALCULATE THE AVERAGE OF THE AVERAGE WIDTH OF THE N PICTURES
118
IS THE AVERAGE WIDTH < 1st THRESHOLD ?
120
YES
SELL AS CHIPS
122
NO
IS THE AVERAGE WIDTH < 2nd THRESHOLD ?
124
YES
SELL AS GREEN
126
NO
IS THE AVERAGE WIDTH < 3rd THRESHOLD ?
128
YES
DRY AS FIR
130
NO
DRY AS SPRUCE
132

FIG. 4

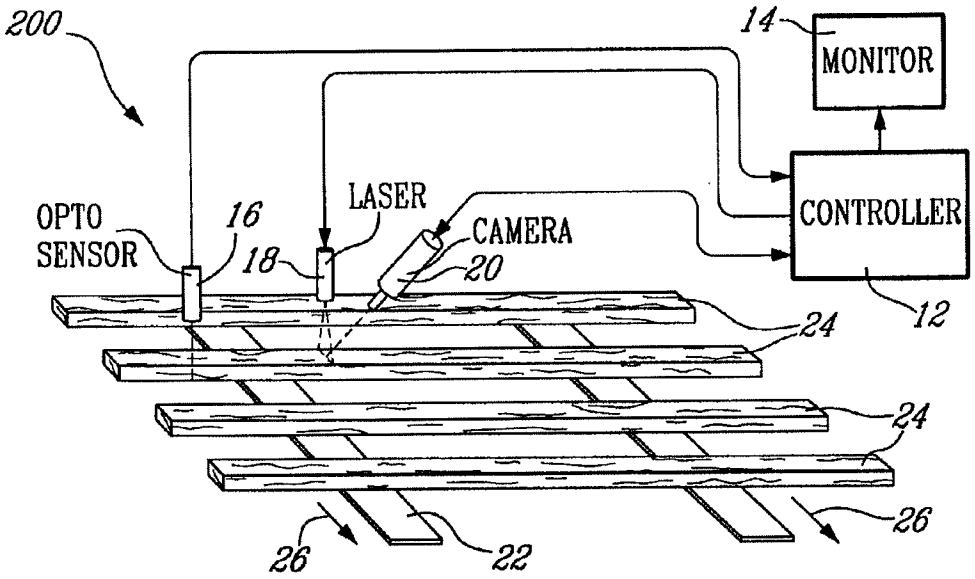

Fig. 5

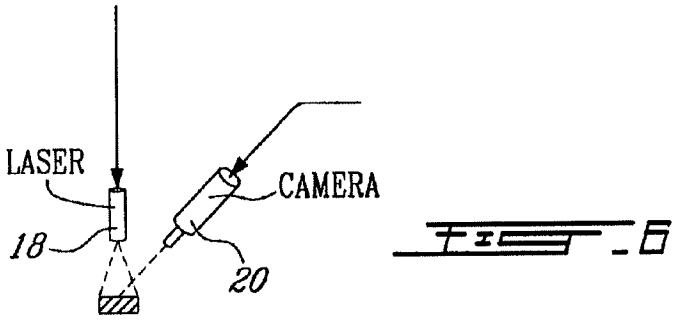

Fig. 6

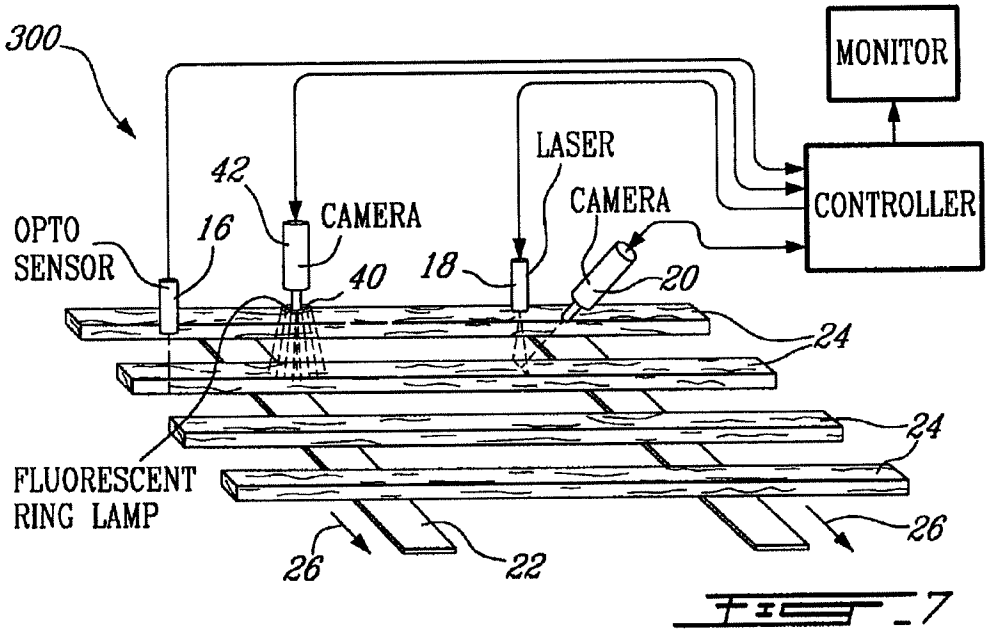

Fig. 7